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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Forming Tube for Glass Fibers.

We, SONOCO PRODUCTS COMPANY, a company organized and existing under the laws of the State of South Carolina, United States of America, of Hartsville, South Carolina, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to glass fiber manufacturing and more particularly to a carrier or "forming tube" for use in the winding of freshly spun glass filaments or fibers.

In the spinning of glass fibers to be processed into textile material such as yarn and the like, glass in a molten condition is drawn through small openings or orifices in a plate commonly referred to as a spinneret into the the form of continuous filaments which solidify upon contact with the air. These continuously drawn filaments are wound onto a tubular carrier in the form of a flexible cylindrical sleeve which is generally referred to as a "forming tube". In a glass fiber spinning operation, this forming tube is slipped onto a spindle or the like which is rotated at very high speeds, frequently around 8,000 to 10,000 rpm and up, and the glass filaments are drawn from the spinneret and wound on the tube at a relatively high linear speed generally 3000 to 3600 m per minute and more. These forming tubes are used not only for such a winding operation but for subsequnt winding and unwinding operations as well.

Due to the high speed at which the forming tube is rotated and the rugged conditions of use to which it is subjected, these tubes must meet rigid standards and preferably should be of a suitable design and material so as not only to be inexpensive in initial cost but to be capable of repeated use. Furthermore, these forming tubes must be provided with external surface characteristics specifically suitable for the glass fiber winding and unwinding operations for which they are used. In general, it can be said that such tubes are required to have a relatively smooth peripheral surface to permit the glass fibers to be readily unwound from the tube and at the same time this peripheral surface should be sufficiently rough so that satisfactory winding of the fibers on the tube may be accomplished. In addition, these tubes should also be of light weight to avoid deformation by centrifugal force which at the speeds referred to above is of a substantial magnitude. Furthermore, these forming tubes should be highly resistant to compression by the fibers wound tightly on the tube so that the tube maintains its shape after removal from the spindle and the tubes should have sufficient flexibility and elasticity to permit their ready removal from the wound package of glass fibers when the tube is to be re-used.

Two commonly employed materials in use today for making such forming tubes are plain paper or paperboard and plastics material such as polyethylene both of which have objectionable features. Although a forming tube composed solely of ordinary paperboard generally performs satisfactorily the first time it is used, its inherent lack of strength and lack of flexibility causes it to deteriorate rapidly when re-used. It is thought that the rapid deterioration of such paper forming tubes occurs primarily as a result of the breaking of the cellulosic fibers in the tube resulting from the bending and folding to which such paper tubes are subjected. Therefore, forming tubes of fibrous material such as paper or paperboard are generally discarded after a few uses or even

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after a single use adding considerably to the manufacturing costs of such glass fibers even though the initial cost of such paper tubes is low. Forming tubes of plastics material have also been used with some success but the severe stresses to which plastics material forming tubes are subjected frequently causes tubes of plastics material to disintegrate or "explode" during use primarily as a result of centrifugal force not only creating a hazard but, as a result of the high initial cost of such plastic tubes, adding considerably to manufacturing costs.

According to one aspect of the invention there is provided a non-rigid forming tube for glass fibers comprising at least one spirally wound inner ply of paper and a spirally wound outer ply of resin impregnated paper having a hard, uniformly smooth, slick outer surface for the winding of glass fibers, characterized in that the inner and outer paper plies have fiber lying generally in the direction of the longitudinal axis of the plies and are spirally wound at a winding angle within the range of 17 to 35 degrees, the forming tube being flexible so that it can be collapsed longitudinally and removed from a package of glass fibers wound on the forming tube.

According to another aspect of the invention there is provided a method of winding a non-rigid forming tube for glass fibers according to the previous paragraph, characterized by spirally winding at least one strip of paper at a winding angle within the range of 17 to 35 degrees to form a tubular inner ply, impregnating another strip of paper having a flexibility, porosity and strength greater than the one strip of paper with a resin, spirally winding the resin impregnated strip of paper in overlying relationship with the spirally wound inner ply to form an outer ply, spirally winding a strip of release material on the resin impregnated outer ply, and permitting the resin in the outer ply to cure to provide a forming tube having a hard, uniformly smooth, slick outer surface and removing the release material.

An example of the invention will now be described with reference to the accompanying drawing in which:

Figure 1 is a diagrammatic illustration of tube winding apparatus for winding the forming tube of the invention;

Figure 2 is a sectional view taken substantially along line 2—2 of Figure 1 in the direction of the arrows;

Figure 3 is an enlarged isometric view of the tube of the invention as wound on the apparatus of Figure 1;

Figure 4 is an enlarged sectional view taken substantially along line 4—4 of Figure 3 in the direction of the arrows; and

Figure 5 is a view similar to Figure 4 showing the forming tube of the invention in a collapsed condition.

Referring now to the drawing and to Figure 1 in particular, there is shown diagrammatically a typical spiral tube winding apparatus by means of which the winding of the forming tube of the invention is carried out. As previously stated, the forming tube of the invention, which is shown in section and designated generally by the numeral 11 in Figures 4, 5, is of the type which is particularly suitable for use in the winding of freshly spun glass filaments or fibers drawn from a spinneret of a glass furnace. However, the tube 11 of the invention may also be employed in other glass fiber manufacturing operations involving glass fiber winding and take-off procedures.

As generally illustrative of the method of winding the forming tube 11 of the invention, the conventional spiral tube winding apparatus of Figure 1 is designated generally by the numeral 12. This spiral tube winding apparatus 12 is shown carrying out a winding operation by means of which a continuous tube T advanced in the direction of the arrow I is produced. The tube T is cut into suitable lengths to form the forming tube 11 of the invention as will be explained hereinafter.

As is well known, the spiral tube winding apparatus 12 comprises a frame 13, a stationary mandrel 14 supported on the frame, a flexible endless belt 16 extending around a pair of pulleys 17 at least one of which is driven for rotating and advancing the tube T as it is formed and a cutoff device 18 for cutting the continuously wound tube T into uniform sections of a selected length.

In the winding of the continuous tube T, at least one strip 21 of paper unwound from a supply roll 22 is first wound on the tube making mandrel 14. Preferably, two such paper strips are employed and accordingly a second paper strip 23 unwound from a supply roll 24 is wound in overlying staggered relationship with and at the same angle as the strip 21 from the opposite side of the mandrel 12. The paper strips 21, 23 which contain cellulosic fibers common to paper have the fibers extending lengthwise in the direction of the longitudinal axis of the paper strips or what is generally referred to as the "paper machine direction".

As shown in Figure 1, the angle at which the paper strips 21, 23 are wound onto the mandrel 14 is preferably within the range of 17 to 35 degrees relative to the longitudinal axis of the mandrel 14 and, in the illustrated embodiment, the strips 21, 23 are wound at a winding angle of approximately 29 degrees. Thus, at the relatively low winding angle of 29 degrees, the fibers in the strips 21, 23 approach a parallel relationship with the axis of the tube T for a purpose to be explained hereinafter.

In order to adhere the paper strips 21, 23 together in the spirally wound relationship, the paper strip 23 is advanced in contact with an applicator roll 26 suitably supported for rotation in a receptacle 27 containing a suitable adhesive in the well known manner. Thus, the applicator roll 26, as it rotates, applies adhesive to the underside of strip 23. Contact between the strip 23 and the applicator roll 26 is maintained by advancing the strip 23 under guide rollers 28, 29 also suitably supported for rotation on the receptacle 27.

In this manner, the two paper strips 21, 23, spirally wound with adhesive therebetween, form a two ply tube 31 which is advanced under the belt 16 in the direction of the arrow I. The paper strips 21, 23 are preferably each wound with the edges of adjacent convolutions in an abutting relationship. As shown in Figure 3, paper tube 31 is therefore provided with a spiral butt seam 23*a* and paper ply 21 is provided with a butt seam 21*a*.

As the paper tube 31 advances along the mandrel 14 down from the belt 16, a strip 32 of paper impregnated with a suitable resin is spirally wound in overlying relationship with the wound paper ply 23 of the wound paper tube 31 to form a spirally wound outer ply. Strip 32 is also of paper but is of the type of paper which is of greater porosity and flexibility as well as greater strength than the paper plies 21, 23. For instance, a type of paper commonly referred to as "Kraft" paper is preferably used for the outer ply 32. The winding angle of the Kraft paper strip 32 is also within the range of 17—23 degrees and, as shown, is preferably wound at an angle of 29 degrees.

The strip 32 is unwound from a supply roll 33 and is impregnated with a suitably resinous material by advancing the strip 32 through a receptacle 34 containing an impregnating resinous material 36 as shown in Figure 2. Preferably, the resinous material 36 is an acrylic resin which is provided in the form of an aqueous emulsion. The curing of this resinous material 36 may therefore be accomplished by the evaporation of the water vehicle from the acrylic resin and water mixture. Guide rollers 37—40 are suitably positioned, as shown in Figure 2, adjacent the receptacle 34 so that the strip 32 is immersed in the resinous material bath 36 and subsequently removed for winding on the paper tube 31. Preferably, the impregnated strip 32 is wound with the edges of adjacent convolutions in overlapping relationship as shown best in Figure 3 which form an outer spiral seam 32*a*.

In order to provide a hard, uniformly smooth, slick surface on the impregnated paper ply 32 after the resin is cured, a wrapping ply 42 of smooth, slick, release material such as polyethylene, Mylar (Registered Trade Mark) or the like is unwound from a supply roll 43 and spirally wrapped as shown in Figures 1, 3 in overlying relationship with the impregnated outer paper ply 32. The ply 42 is preferably wrapped with the edges of adjacent convolutions in overlapping relationship as shown to form an outer spiral seam 42*a* completely covering the underlying resin impregnated ply 32. With the use of release material for the ply 42, it does not adhere to the resinous material with which the paper ply 32 is impregnated and ply 42 is tightly wound in the spiral winding operation of Figure 1 with the underlying ply 32 to form the tube T. The tight engagement of wrapping ply 42 with the impregnated paper ply 32 not only confines the resin within ply 32 but produces a substantially complete engagement between the surfaces of the two plies.

As the continuously formed tube T moves in the direction of the arrow I, it enters the cut-off device 18 in which it is cut into uniform sections which are removed for curing. Preferably these tube section are formed approximately 2,5 m in length. The curing of the sections severed from the tube T is then carried out so that the water vehicle in the resin-water mixture in the tube outer ply 32 will be evaporated and the resin with which the tube T is impregnated will set permanently. Using an aqueous acrylic resin mixture for impregnation of the tube ply 32 permits the curing to be accomplished under normal room temperatures over a relatively short period of time. However, if it is desired to shorten the curing time by the application of heat, means such as an oven can be utilized.

After curing, the tube sections are then cut into a plurality of short lengths, preferably lengths of approximately 20 cm to provide forming tubes 11 of a length suitable for use in a glass fiber winding and unwinding operation.

As a result of the high degree of porosity of the paper ply 32, a substantial amount of resinous material 36 is absorbed into the outer ply 32. In addition, the flexibility of the paper strip 32 permits the ply to adhere in a continuous bond to the underlying paper ply 23 of the paper tube 31. When the resin in the Kraft paper outer ply 32 is cured, it forms a winding surface which is not only hard and durable but uniformly smooth and slick so as to be ideally suitable for the winding and unwinding of glass fibers in certain operations.

The forming tube 11 of the invention is not only characterized by high strength and durability so as to be capable of repeated use with a minimum of deterioration but it may be easily removed from the package of glass fibers wound thereon by collapsing the tube 11. As a result of the positioning of the fibers in the paper strips 21, 23 and 32 at an angle approaching the angle of the axis of the tube T using a low strip winding angle of 17 to 35 degrees, the collapsing of the tube 11, which is accomplished by folding the tube longitudinally as shown in Figure 5, does not produce a folding across the fibers but rather a folding in the general direction of the fibers so as to avoid fiber breakage thereby promoting long life for the tube 11.

WHAT WE CLAIM IS:—

1. A non-rigid forming tube for glass fibers comprising at least one spirally wound inner ply of paper and a spirally wound outer ply of resin impregnated paper having a hard, uniformly smooth, slick outer surface for the winding of glass fibers, characterized in that the inner and outer paper plies have fiber lying generally in the direction of the longitudinal axis of the plies and are spirally wound at a winding angle within the range of 17 to 35 degrees, the forming tube being flexible so that it can be collapsed longitudinally and removed from a package of glass fibers wound on the forming tube.

2. A method of winding a non-rigid forming tube for glass fibers according to claim 1, characterized by spirally winding at least one strip of paper at a winding angle within the range of 17 to 35 degrees to form a tubular inner ply, impregnating another strip of paper having a flexibility, porosity and strength greater than the one strip of paper with a resin, spirally winding the resin impregnated strip of paper in overlying relationship with the spirally wound inner ply to form an outer ply, spirally winding a strip of release material on the resin impregnated outer ply and permitting the resin in the outer ply to cure to provide a forming tube having a hard, uniformly smooth, slick outer surface and removing the release material.

3. A non-rigid forming tube substantially as herein described with reference to and as illustrated in the accompanying drawing.

4. A method of winding a non-rigid forming tube substantially as herein described with reference to and as illustrated in the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG. 1.

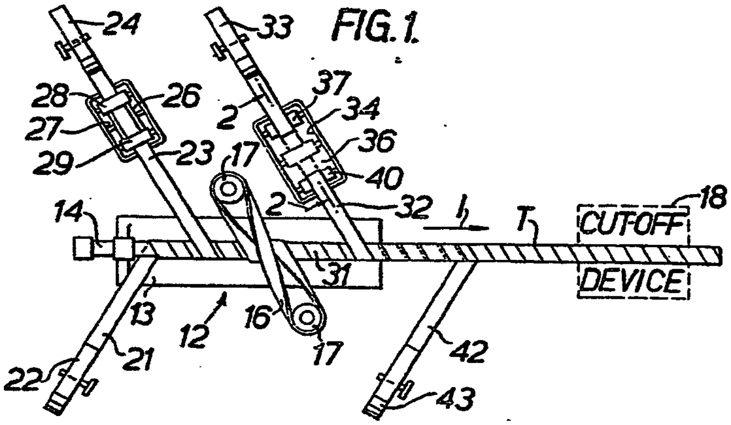


FIG. 2.

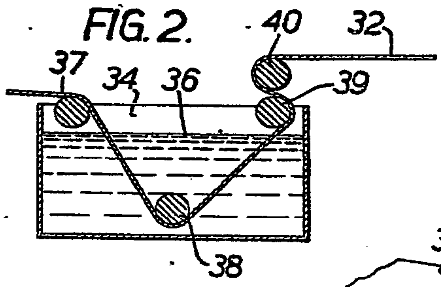


FIG. 3.

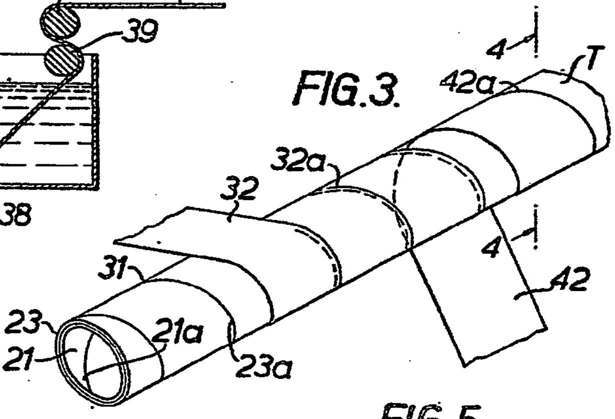


FIG. 4.

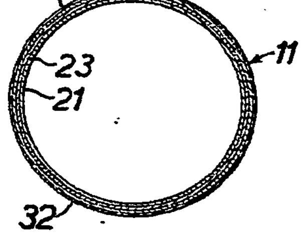
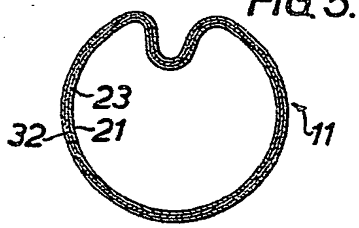


FIG. 5.



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